Forests

7

Forests

Forests spread over roughly 26 percent of North America's land area (see Figure 38) and represent 12 percent of the world's forests. North America has over one-third of the world's boreal forests (see Box 40) as well as a wide range of other forest types. Over 96 percent is natural forest. After Russia and Brazil, Canada has more forest than any other country, with 244.6 million ha covering 26.5 percent of the total land area. The United States is the fourth most forested country, with 226 million ha, representing about 25 percent of the country's land area (FAO 2001a).

While Canada's forest area remained virtually unchanged during 1990–2000, the United States forest area increased by almost 3.9 million ha—or approximately 1.7 percent. Recent estimates (late-1990s) show that North America grows 255.5 million m^3 more timber annually than is harvested (see Figure 39) (UN-ECE and FAO 2000).

In Canada, 94 percent of forests are publicly owned, with the provinces responsible for 71 percent of total forested land (NRCan 2000a). In contrast, some 60 percent of US forests are privately owned, 35 percent are publicly owned and managed by the federal government, while the 50 states own and manage 5 percent (UN 1997).

The number of plantations (usually considered closely planted trees in neat rows) and areas replanted more randomly with seed-

Forest Extent

Figure 38
Forest extent.

Source: FAO 2001a

Box 40: Boreal Forests

The boreal forest is one of the world's largest terrestrial ecosystems. It is a belt of coniferous forest around the northern hemisphere covering about 17 percent of the earth's land. North America's boreal forests stretch across the northern part of continent from the province of Newfoundland on the east coast, over half the Prairie Provinces, and throughout the Yukon territories and the state of Alaska. It covers 341 million ha in Canada, representing about 30 percent of the world's boreal forest, and 46 million ha in Alaska, which makes it the largest North American forest ecosystem (TRN 1998; Gawthrop 1999).

The boreal landscape, called *taiga* in Russia, is characterized by a diverse mosaic of forests of various ages and composition, relatively few tree species, large peat bogs, and a web of shrubs, mosses, lichens, and other organisms. The plants and animals are adapted to the cold climate, a short growing season, and repeated naturally occurring forest fires (BFW 1997; Gawthrop 1999).

Over the past 30 years, there has been a large increase in global consumption of wood products, primarily paper, and the boreal forest is a major supplier of wood and fibers to world markets. Over the last three decades some areas have been subject to increased environmental threats: large-scale industrial forestry has rapidly moved into previously un-logged areas of the boreal forest, oil and gas exploitation has grown, and the number and scale of forest fires has increased (TRN 1998). Only about 2.66 percent of Canada's Boreal Shield ecozone (the largest of seven subdivisions of Canada's boreal forests) is strictly protected from all forms of large-scale industrial activities (Urquizo, Bastedo and others 2000).

Unlike the temperate and tropical forests of the south, where trees are more majestic and grow in close stands, the boreal forest and potential threats to its sustainability have not inspired the same public interest as the forests of the Pacific Northwest (Gawthrop 1999).

lings or seed after harvesting is increasing. For example, the area successfully regenerated by planting and seeding in Canada expanded from 10,090 ha in 1975 to 297,820 ha in 1997 (NFDP 1998). The United States has about 21 million ha of plantations or about 4.5 percent of its forested land base (UN-ECE and FAO 2000).

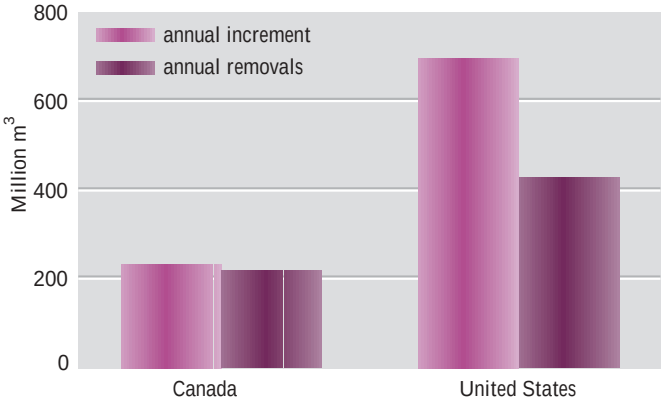
Large tracts of North American forests have been designated as protected areas. In 1995, Canada had protected about 32 million hectares (7.6 percent) of its forested lands (not counting those under provincial protection), and 67 million ha (30 percent) of US forests enjoyed some status of protection (University of Waterloo 1998; FAO 2001a).

Human intervention is the principal driving force behind forest degradation, and human demand for wood products such as timber

Figure 39
Annual timber increment and annual removals on available forest land, late 1990s

Source: UN-ECE and FAO 2000

Annual Timber Increment and Annual Removals on Available Forest Land, Late 1990s



Box 41: Forest Health

In the past, a forest was deemed healthy if it was free of insects and disease and was growing vigorously (NRCan 1999). Over the past 20 years, however, the long-term sustainability of the forest ecosystem has become the primary measure of forest health (UN-ECE and FAO 2000). A forest may be considered healthy when it maintains biodiversity and resiliency; provides wildlife habitat, ecological services, and aesthetic appeal; and maintains a sustainable supply of timber and non-timber resources (NRCan 1999). Some level of fire, insects, and disease is recognized as a natural component of healthy forests. By these measures, past harvesting practices, the introduction of exotic species, and suppression of natural disturbances have created large forested landscapes with an unnatural tree distribution and age structure, which has increased the forest's vulnerability to drought, wind, insects, disease, and fire (UN 1997; USDA 1997). For example, as shown in the disasters section, decades of aggressive fire suppression contributed to major ecological change in some of North America's forest ecosystems so that the structural homogeneity of many new tree stands render them less diverse and resilient than their natural predecessors (Stuart 1998).

and paper is the primary driver of forest modification. The region accounts for about 40 percent of the world's production and consumption of industrial wood products (Mathews and Hammond 1999). In some areas, forests are becoming increasingly fragmented, biologically impoverished, and weakened or stressed, and the resulting changes in forest ecosystem structure and age appear to be factors in increased forest damage by fire, drought, pests, and air pollution (Bryant, Nielsen, and Tangley 1997). Maintaining healthy forest ecosystems is a priority issue.

One region in which new forests cannot replace the economic, cultural, or ecosystem value of previous growth is the Pacific Northwest coast of North America. The region's old-growth forests have become an issue of priority concern in North America, in some part due to campaigns against logging over the past 30 years that brought the issue to international attention.

Forest Health

Although North America's forest area is now relatively stable, a mixture of changing conditions in the semi-natural forests in many areas may be responsible for deteriorating health (see Box 41). For example, a significant warming trend and increased lightning, tree age factors, fire-fighting policy, harvesting, forest fragmentation, pollution, and invasion of non-native species are likely to be implicated in the doubling of the area annually disturbed by fire and insects in the boreal forests of central and northwestern Canada over the past 20 to 30 years compared to the previous 50-year period (Urquizo, Bastedo and others 2000; Bruce, Burton, and Egener 1999).

In the United States, the results of a number of reports from the mid-1990s show that northeastern forests were generally healthy, although particular species in localized areas showed cause for concern. Chronic and quite extensive decline was

noted in the high-elevation spruce-fir forests of the northeast US, and serious declines for red spruce in the 1980s across the northeastern Appalachian Mountains and in some regions of the southern Appalachians were reported (McLaughlin 1996).

Invasive exotic diseases have been a principal cause of changes to North American forest ecosystems and continue to threaten forests (Mattoon 1998). For example, the American chestnut and elm are now functionally extinct due to exotic pathogens while the mellaleuca and miconia have invaded large areas of Florida and Hawaii, respectively, displacing native vegetation and transforming wildlife habitat (UN 1997, USDA 1997). The hemlock woolly adelgid is attacking the eastern hemlock, and entire stands are disappearing in parts of New England. And a fungal pathogen, the butternut canker, is affecting the butternut while the eastern and western flowering dogwoods are being affected by another fungal pathogen, the dogwood anthracnose (Mattoon 1998).

One of the most widespread and damaging invasive insects has been the gypsy moth caterpillar, which caused between 25 and 100 percent defoliation of more than 608,000 ha of northeastern forests in 1971 and destroyed about US $764 million worth of timber in 1981. It now occurs throughout the Northeast (Porter and Hill 1998). In all, it has been estimated that resource values on some 9.72 million ha of national forest in the United States are at high risk of loss over the next 15 years due to insects and disease, with mortality potentially exceeding 25 percent of expected background rates (or average rate of probability of death) (Bartuska 2000).

Exotic invasives are now second to habitat loss and human modification of forest ecosystems as the largest threat to biodiversity. Logging, suburban development, and other land use changes have continued to destroy or modify forest ecosystems over the past 30 years, threatening forest-dwelling species. About two-thirds of Canada's 140,000 species of plants, animals, and microorganisms live in forest habitats. One-quarter of all its species-at-risk are forest dependent. The abundance and distribution of the woodland caribou and wolverine, two of Canada's flagship wilderness species, decline with just low levels of forest disturbance and fragmentation (GFW2000). Of the 1,049 species of plants and animals listed under the US Endangered Species Act (ESA) in 1997, all of 332 occur in national forests. In the southern Appalachian forest ecosystem, 260 aquatic species are at risk. Key salmon and trout species inhabit decreasing areas of their former range in the forested interior Columbia River Basin (USDA 1997). And it is estimated that about 198 tree species are threatened in the United States (UNDP, UNEP, World Bank, and WRI 2000).

Human modification of forest ecosystems through unsustainable harvesting methods can also contrib-

ute to degraded forest quality. For example, the Acadian mixed wood forest in the province of New Brunswick is gradually disappearing due to more than a century of high-grade logging. Late-successional species that require protection to regenerate are being replaced by lower-value, short-lived species. Appropriate silviculture has had considerable success in restoring 'protection-requiring' species, however, and if implemented could begin to replace present clear-cutting methods (see Box 45), allowing for the return of complex species assemblages and a more diverse ecosystem (Salonius 2001).

Exotic species and modifications to forest age and structure are part of a complex mix of pressures that affect the health of North America's forest ecosystems. Air pollution is increasingly recognized as a contributing factor in some areas (Bright 1999). It has played a role in the major die-off of high-elevation spruce-fir forests in the southern Appalachians, a region that has been the focus of concern for the US Forest Service (USDA 1997; Mattoon 1998) (see Box 42).

Although pollution regulation over the past 30 years has reduced acid rain in the northeast, evidence is now linking reduced growth in some tree species to its long-term effects (Driscoll, Lawrence, and others 2001). Research conducted by the Acid Rain Action Plan (see Box 43) shows acid deposition in areas of relatively poor soils resulted in both

Box 42: Stresses to the Eastern Forests

Evidence of declining tree health in North America's eastern forests illustrates the impact of overlapping stresses on forest ecosystems. Here, second-growth woodlands have spread over old woodlots and abandoned farms and fields in the past century. One of the major factors affecting their health is human amplification of the nitrogen cycle, which has been boosted by fertilizers, fossil fuel combustion from cars and power plants, and wetland drainage. Nitrogen oxides help to form ozone pollution (see Box 4 in the atmosphere section), which is responsible for significant tree damage in this region. Exposure to ozone correlates with die-offs of hickory and oak and injuries to the tulip poplar and magnolia. Ozone exposure also appears to play a role in reducing photosynthesis, leading to chronic leaf damage and, in turn, root failure and a syndrome of 'falling forest' (Bright 1999).

Nitric acid also contributes to acid rain. Essential minerals have been leached from the soil from past decades of acid rain, impairing the ability of the needles of the region's most important conifers to function properly in the winter. It is thought that this has contributed to the death of 75 percent of mature red spruce in the higher elevations of Vermont's Green Mountains. Nitrogen pollution is also making forests more vulnerable to native and exotic insects and disease. Such conditions have played a role in the mortality of sugar maple, and threats to the American beech and eastern hemlock (Bright 1999). Together with other biotic and abiotic stresses, acidic cloud water has contributed to predisposing red spruce in the high elevations of the northeast US Appalachians to winter injury, causing mortality and regional decline (McLaughlin 1996). A survey of five eastern US states found that overall, tree mortality may be three to five times historical levels (Mattoon 1998).

acidification and the depletion of calcium and magnesium, which are essential for tree growth (EC 2000). In Canada, the sugar maple has been the focus of studies on forest decline. Although the balance of evidence has shown no regional sugar maple decline, it is also evident that increasing crown transparency noted in southern Quebec and central Ontario is spatially correlated with the regional pollution gradient (McLaughlin 1996). A trend, albeit somewhat inconsistent, showed that where acid deposition was high, especially as a result of nitrates, crowns were thinner (Hopkin, Lachance, and others 1996).

The long-term response to the impact of tropospheric ozone, acid rain, and other stressors is being monitored nationally by programs such as the US Forest Health Monitoring Program, Canada's Ecological Monitoring and Assessment Network, and the 1984 Acid Rain National Early Warning System (ARNEWS), as well as through a number of bilateral initiatives (see Box 43).

Another underlying cause of changing forest conditions is the historical lack of recognition in forest policy of the ecological, recreational, spiritual, aesthetic, and non-timber values of forest ecosystems and of the importance of working with natural disturbance rather than in opposition to it (see the section on wildfire in the environmental disasters chapter) (USDA 1997; WRM 1998). Since the 1992 United Nations Conference on the Environment and Development (UNCED), North American governments have changed the definition of sustainable forestry from promoting a sustained yield of fiber to

Box 43: Bilateral Cooperation

Canada and the United States cooperate to assess the health of their forests. Established in 1958, the North American Forestry Commission, (NAFC) is one of FAO's six regional forestry commissions. NAFC supports research and natural resource management activities of mutual concern through seven working groups: atmospheric change, fire management, forest products, insects and diseases, silviculture, forest inventory and monitoring, and forest genetic resources. The atmospheric change group, for example, promotes the collection, exchange, and dissemination of information and techniques for monitoring forest health and evaluating the effects of atmospheric change on forests (NAFC 2000).

Canada and the United States also cooperate to assess the impacts of air pollution and acid deposition on forest ecosystems through a forest-mapping initiative included in the Acid Rain Action Plan adopted by the Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP)(EC 2000). Forestry Canada and the US Forest Service work together as part of the North American Maple Project (NAMP) established in 62 locations in 11 states and four provinces. A system was erected to identify the types and extent of damage to forests as well as its natural and anthropogenic causes (NRCan 1995, CAS 2002).

addressing the health and sustainability of forest ecosystems. The new definition focuses on the stewardship and use of forest land at local, regional, national, and global levels in a way and at a rate that maintains their health—their biodiversity, productivity, regeneration capacity, and vitality—and their potential to fulfil relevant ecological, economic, and social functions now and in the future, without damaging other ecosystems. This shift has meant changes in how forestlands are examined, policy is formulated, and programs are designed and implemented (UN 1997; Apsey, Laishley, and others 2000).

Both countries are part of the Montreal Process on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests (The Montreal Process), an international agreement signed in 1994. Its Working Group agreed on a common definition of sustainable management and identified seven criteria and 67 associated indicators that define its characteristics. Their use should ensure the compatibility of national criteria and indicators with internationally recognized scientific standards (MPCI 1998). In the United States, the US Forest Service (USFS) has incorporated the concept of sustainable forestry and in 1999, it strengthened this emphasis with the development of sustainability criteria and indicators for management of the National Forest System. As part of the Montreal Process, the USFS is

producing a major technical evaluation of the state of the Nation's forests and of progress toward sustainable forest management to be ready in 2003, with input from public workshops held by the Roundtable on Sustainable Forests (UN 1997; USDA 2002).

Canada's commitment to sustainable forestry is reflected in its 1992 Forest Accord and National Forest Strategy, which introduced a multiuse forest management perspective recognizing the non-timber values of forests and the need for information that transcends political boundaries. The 1998–2003 strategy includes the Canadian Council of Forest Ministers' set of criteria and indicators of sustainable forest management, which was reinforced by the Montreal Process, as well as ongoing research conducted by Natural Resources Canada (NRCan 2000a; NRCan 2000b).

Many state and provincial initiatives also reflect a shift to sustainable ecosystem management, including a legislated requirement to integrate economic, environmental, and social interests in forest management; decreases in the size of harvesting areas; new harvesting methods for better natural regeneration; improved silviculture methods; the use of natural resource inventories; and public participation (UN 1997). Largely in response to public pressure, forest management over the past 20 years has incorporated a new emphasis on maintaining wildlife habitat, protecting soils, and retaining natural landscape characteristics and natural disturbances such as wildfires. In addition, as shown below in the old-growth section, some timber companies have also incorporated new forms of management to sustain economic activity, local communities, forest resources, wildlife habitat, and ecosystem functions.

An emerging issue in maintaining healthy forests is the potential impact of climate change and consideration of the connections between climate change and other damaging influences (NRCan 1999). Higher temperatures could lead to an increase in insect populations and outbreaks of fire, which can have devastating effects. For example, during an outbreak of the spruce budworm in eastern Canada between 1970 and the mid-1980s, some 55 million ha of forest were defoliated. Previously unknown in the forests north of the Alaska mountain range, this insect has defoliated some 23,000 ha (Gawthrop 1999).

Existing conditions in many forest stands throughout North America make them less resistant to catastrophic outbreaks of insects, diseases, and fires, which in turn reduces habitat diversity and utilizable timber, adding CO_2 to the atmosphere (Taylor 1997). North America's forests, particularly its broadleaf ecosystems, which appear to have a large capacity for carbon absorption, are unlikely to maintain their absorption attributes in an unhealthy state (Bright 1999). Evidence suggests that until about 1970, Canada's boreal forests took up more than half of the carbon emitted by that country, but by the end of the 1990s, they had begun to

lose carbon as natural and human disturbance that increased forest fires and insect infestations turned the boreal region from a sink to a source of atmospheric carbon. The International Panel on Climate Change has reported that higher temperatures are likely to lead to

Distribution of Coastal Temperate Rain Forest by State/Province

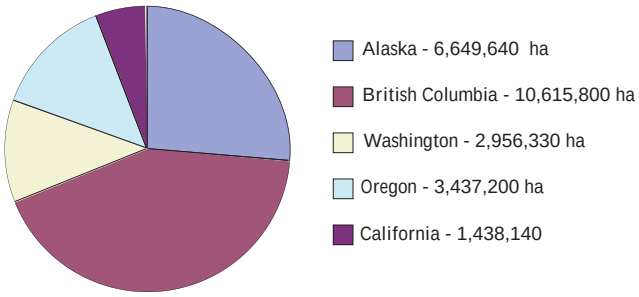


Figure 40
Distribution of coastal temperate rain forest by state/province.

Source: BC Ministry of Forests 1998

the eventual replacement of much of the boreal forest by grasslands, temperate forest, or tundra (Gawthrop 1999; NRCan 2000c).

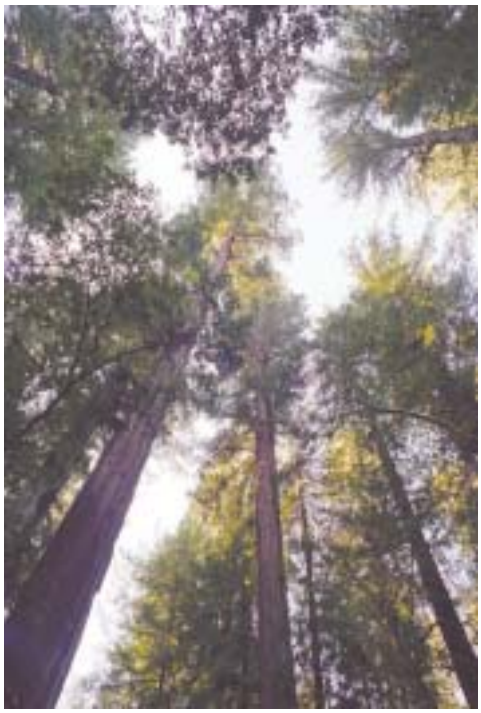
As management practices place greater value on non-timber attributes, as more forested lands are protected from logging, and as a weakened forest's ability to absorb carbon is questioned, the importance of reducing North America's consumption of both wood products and fossil fuels should become ever more apparent.

Old-Growth Forests in the Pacific Northwest

Old-growth (see Box 44) forests once occurred in all North America's ecosystems. Although lack of historical data and inventory definitional problems make it difficult to determine exactly how much old growth there was, remnant old-growth forests and stands still remain in many ecosystems throughout the region, but especially in the Pacific Northwest, the Rocky Mountains, and the Pacific Southwest. Most of the remaining old-growth forests occur in the Pacific Northwest along the coast from Alaska through British Columbia (BC) and the states of Washington and Oregon to California. The classic old-growth forest in this area contains redwoods, cedars, Douglas fir, hemlock, or spruce. The region probably still (in 1998) contained about half the world's remaining un-logged coastal temperate rainforest, with the

Box 44: Old Growth

There is no broadly accepted definition of old growth, but it generally refers to ecosystems characterized by stands of very large and old trees, a distinct species composition, a multi-layered canopy, and a large buildup of organic matter (Lund 2000). The forests may or may not have been disturbed by humans. Old-growth forests supply high-value timber, contain large amounts of carbon, harbor a large reservoir of genetic diversity, provide habitat for many species of fauna and flora, regulate hydrologic regimes, protect soils and conserve nutrients, and have substantial recreational and aesthetic value (Marchak, Aycock, and Herbert 1999). Their trees have many nest cavities for birds and small mammals and the forest is littered with decaying trees and debris that provide habitat for rodents, insects, and reptiles (Dietrich 1992). Some 40 of 118 known vertebrate species that live primarily in old-growth forests may not be able to nest, breed, or forage anywhere else (PBS 1999). Temperate old-growth forests have been and still are home to many indigenous and tribal peoples. Much of the interest in old-growth forests stems from the powerful images they project of rich biodiversity and timeless stability. Many visitors sense a form of spirituality and grandeur in such forests, and most people place a high value on them.



greatest share in BC (see Figure 40). Old growth makes up 31 to 43 percent of the province's forests (see Figure 41) (BC Ministry of Forests 2001a).

The majority of old-growth losses in the eastern and lower elevations of North America came about through conversion of lands to agriculture and urban environments. In the west and mountainous regions, loss has resulted from harvesting of timber and conversion to younger, more vigorously growing stands along with recent catastrophic events like the eruption of Mt. St. Helens and the Yellowstone fires (see Box 52 in the environmental disasters section) (Harmon 1993; H. John Heinz III Center 1999). Figure 42 shows the decline in the percentage of total old-growth forest area in US west coast states. The remaining old-growth forests in these states are characterized by highly fragmented stands of clear-cuts, thinned areas, young plantations, stands of mature growth, and extensive road systems (Turner, Carpenter, and others 1998).

With population growth, demand for timber, and technological improvements in the logging industry, the rate of logging in the Pacific Northwest increased dramatically after the 1950s. The introduction of

Old-Growth Forest in British Columbia

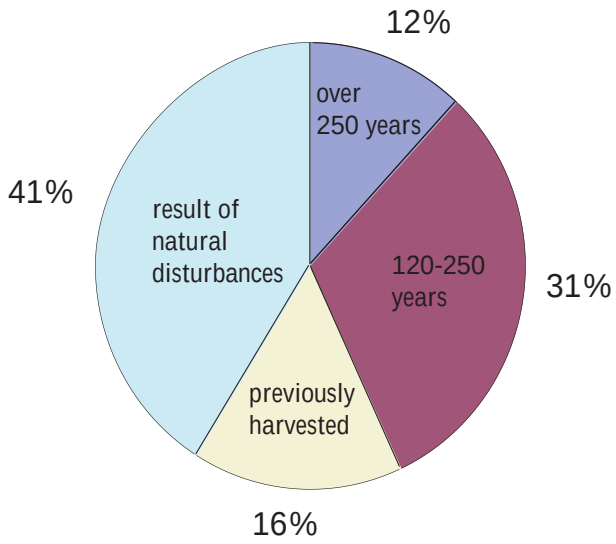


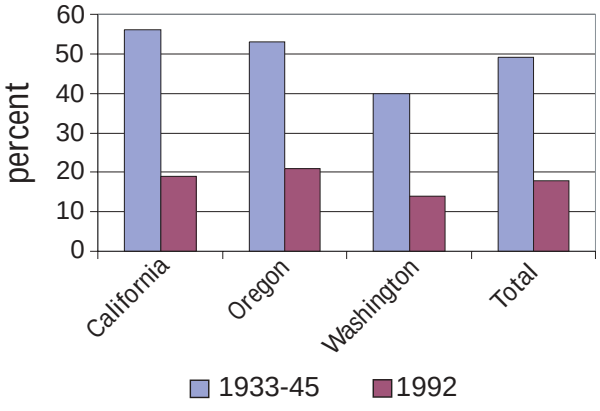
Figure 41
Old-growth forest in British Columbia.

Source: BC Ministry of Forests 2001a

Figure 42
Change in old-growth forest area in California, Oregon, and Washington, 1933-45 to 1992.

Source: H. John Heinz II Center 2001

Change in Old-Growth Forest Area in California, Oregon, and Washington, 1933-45 to 1992



Box 45: Clear-Cutting

Clear-cutting is a simple, efficient, and cost-effective means to extract timber, whereby all trees in a given area are cut down and the saleable stock removed (Jones, Griggs, and Fredricksen 2000). Earlier, clear-cuts were thought to mimic forests gaps formed by natural disturbances. But today, many environmentalists consider clear-cutting to be destructive, unsightly, and unsustainable. They argue that it is practiced more frequently than the natural large-scale disturbances it has been said to mimic (Hammond 1993). The new vegetation does not maintain the complexity and stability of old forests that makes the latter storehouses for a diversity of genetic codes and uncommon species (Maser 1993). Furthermore, clear-cutting in sensitive ecosystems can cause soil erosion, landslides, and silting, which in turn can damage watersheds, lead to flooding, and inhibit the reproductive success of fish eggs, which is especially important to the wild salmon of the Pacific Northwest (see the coastal and marine section) (May 1998). It opens large gaps, fragmenting the forest and exposing more kilometers of 'edge' to the wind and increasing the chances of blowdown (Dietrich 1992). With high-profile NGO campaigns against the practice, there has been considerable public outcry over the perceived threats of clear-cutting, which also include the loss of aesthetic and recreational value (PFC 2000).

the chainsaw, the logging truck, and clearcutting (see Box 45) as the dominant harvesting method were important factors in this trend. Tree farming was also introduced at this time, and many clearcut areas began to be reforested with managed stands of short-rotation trees, resulting in blocks of forests of uniform age (Dietrich 1992).

A growing worldwide demand and higher prices in the 1970s drove the rapid harvesting of old-growth timber (Mathews and Hammond 1999). Old-growth losses and the practice of clear-cutting in the 1970s provoked ENGOs in both countries to launch intensive local campaigns to protect the mature forests from harvest (see Boxes 46 and 47).

Box 46: The Spotted Owl

In the United States, the spotted owl, which depends entirely on large tracts of old-growth habitat, became the focus of a much-publicized debate. In 1973, the year the federal Endangered Species Act (ESA) (see Box 10 in the biodiversity section) was passed, the spotted owl was listed as potentially endangered. With each new scientific discovery about the unique needs of this bird, owl researchers, followed by ENGOs attempted to secure protection of ever-larger amounts of old growth to ensure the species' survival. The owl's predicament gave ENGOs the means to seek its protection as an endangered species and to file lawsuits against clear-cutting. In a series of court decisions in 1988 and 1989, they challenged government science and its owl protection plans. Grassroots campaigns in which protesters blocked logging roads and sat in trees soon grew into strategic campaigns by national organizations. Finally, the Forest Service undertook a rigorous impact statement and after a court order in 1991, the US Fish and Wildlife Service declared the owl a threatened species and designated 4.7 million ha outside of parks as 'critical owl habitat' (Dietrich 1992).

Box 47: Clayoquot Sound

In British Columbia, the controversy over old growth focused on sensitive remaining rain-forest areas. Clayoquot Sound, a 1,000 km^2 wilderness on Vancouver Island, became the focus of a debate over old-growth logging. Beginning in 1984, environmentalists and the Nuu-chah-nulth First Nation protested clear-cutting in the rain forest by blocking logging roads, among other tactics. Between 1989 and 1993, government task forces attempted to resolve the conflict, and large tracts of coastal temperate rain forest were set aside for protection (MSRM 2002). In 1994, the 4,000 km^2 Long Beach Model Forest, which encompasses Clayoquot Sound, was established, with the vision of maintaining healthy ecological conditions while safeguarding the well-being of communities, including traditional, non-industrial, and industrial users. As one of 11 model forests in the Canadian Model Forest Network, research is being conducted to develop and test indicators to address old-growth forest issues (NRCan 2000d). Protests continued, however, with claims that logging was still permitted on 70 percent of Clayoquot Sound, bringing national and international attention to the issue (May 1998).

In 1995, in recognition that the Nuu-chah-nulth had not been adequately consulted, public negotiations toward a comprehensive treaty settlement with the First Nation peoples began, and recommendations regarding forest management that recognize other forest values than timber were formulated and adopted by the provincial government (May 1998).

In ensuing years, more progress was made in resolving remaining conflicts and protecting the forests. One of Canada's largest forest products companies announced in 1998 that it would phase out clear-cut harvesting in all its BC operations and design a new stewardship strategy focusing on old-growth conservation and variable retention harvesting instead of clear-cutting (PR Newswire 1998). An agreement was struck between First Nations and environmentalists to set aside most of the western coast of Clayoquot Sound, and to promote economic development through small-scale logging, non-timber forest products, and eco-tourism. With the January 2000 designation of Clayoquot Sound as a UNESCO Biosphere Reserve, industry, environmentalists, governments, and First Nations established a new form of governance based on shared responsibility for the ecosystem (ENS 1999; CNW 2000).

In the 1980s, new forest mechanization technologies improved efficiency (Apsey, Laishley, and others 2000). By the end of the 1980s, old growth was nearly gone from both private and public lands in the US Northwest (Dietrich 1992). Inventory done in 1989 and 1991 showed that 47 percent of coastal BC was still covered with old forest and 9 percent of the coast (678,000 ha of old forest) was in protected areas by the end of the 1980s (McKinnon and Eng 1995). Most industrial-scale logging in Canada took place less than 100 years ago. And since there is little second-growth forest that has reached maturity, most logging today occurs in mature natural forests, except in the coastal region where an increasing proportion of the harvest now comes from second-growth forests (British Columbia Ministry of Forests 2001a). Mature forests are therefore still deemed to be essential to Canada's industrial timber supply.

During the 1990s, the environmental lobby's campaign to protect British Columbia's old growth

broadened to the international arena. ENGOs in the United States focused on persuading lumber and paper consumers in Europe and the Unites States to avoid purchasing products from the region, beginning an international boycott of western Canadian timber products (CBD 2000).

The forestry industry includes large corporations, independent loggers, truckers, pulp and paper mills, and log exporters, who are naturally concerned about jobs and timber revenues in the face of heated public protest. Some logging communities became polarized over the dispute (Pace 1993), reflecting the complex nature of the issue and the difficulty in finding 'win-win' solutions. Timber-related jobs did in fact decline. In Oregon, where timber was the biggest industry in 1988, and Washington, where it was the second biggest, timber employment fell by 30,000 between 1979 and 1989. According to the 1991 spotted owl ruling (see Box 46), the main reasons for loss of timber jobs and mill closures in the Pacific Northwest were modernization, changes in product demand, and

Box 48: Certification, The Forest Stewardship Council

Certification emerged in the past six to seven years in response to international NGO pressure to promote sustainable forestry practices. It is designed to allow consumers and participants to measure forest management practices against approved standards. While enabling consumers to support responsible forestry, certification also provides forest owners with an incentive to maintain and improve forest management practices (Ghazalie 1994).

The Forest Stewardship Council (FSC) is the international leader in setting up a legitimate process to evaluate certifiers for the purposes of accreditation. Founded in 1993, FSC is an international, non-profit NGO formed of representatives from environmental and social groups, the timber industry, the forestry profession, indigenous peoples' organizations, community forestry groups, and certification bodies from at least 25 countries. Its purpose is to support ecologically appropriate, socially responsible, and economically viable management of the world's forests. It provides a model for the development of national and regional standards for evaluating whether and how well a forest is being managed according to a set of global principles and criteria that apply to all forests worldwide.

The FSC certification program is carried out by independent, third-party organizations and is the only one that verifies claims in a 'chain of custody' from the forest through to the final product. Products bearing the FSC label come from a forest managed according to FSC Principles (FSC-Can 1996; FSC-US 2001; NRCan 2001). The FSC's principles and criteria form the model for the development of national initiatives in over 20 countries, which coordinate the development of regional and local standards. The US and Canadian programs were created in 1996, and both countries are developing regional standards. The two countries have 1.8 million ha natural forests certified by FSC-accredited certification bodies (UNDP, UNEP, World Bank and WRI 2000). According to information collected by FAO about the area of forest certified under various certification schemes including FSC, a total of about 30.5 million ha have been certified in the region (FAO 2001b).

competition from elsewhere (Dietrich 1992; Marchak, Aycock, and Herbert 1999).

In response to public pressure, in the 1980s forest policies changed to reflect broader concerns for forest biodiversity and other values. As shown above, until recently, governmental management of forests in both Canada and the United States was based on the doctrine of sustained yield, which had been adopted in the United States and Canada in the first half of the 20th century. It established an upper limit on annual timber harvests, with increased yield to be obtained by controlling cutting on virgin forests and cultivating trees on cutover areas. Management focused on production for timber.

In 1978, the Canadian mandate was redefined to include management of all forest values, including timber, and soon thereafter the Forest Practices Code outlined in great detail how to protect other forest assets. It limited cutblock size, required strips to be reserved along streams, and restricted harvests on unstable soils on steep slopes (Apsey, Laishley, and others 2000; FPB 2002). In BC, sustained yield was replaced by new forest practices that made management more inclusive, such as 'multiple use' and 'integrated resource management'. Similarly, the US 1976 National Forest Management Act reinforced the idea of 'multiple use' and considered other forest values (Dietrich 1992). In addition, more forests were set aside for protection. By about 2000, almost 4 million hectares, or 15 percent, of BC's old growth were fully protected (BC Ministry of Forests 2001a).

Research began into alternative approaches, such as the *Montane Alternative Silvicultural Systems* (MASS) study, a multi-agency cooperative partnership in Canada that built on past silviculture experiences to test new approaches to harvesting and regeneration in mid- to high-elevation montane forests (PFC 2000). And timber companies on the BC coast introduced new methods, such as variable retention, in which individual trees or small plots of trees are left behind, depending on ecological conditions and objectives. The vegetation retained within the cutover areas provides habitat for a variety of insects, birds, mammals, and other plant species. Some operators abandoned clearcutting altogether (NRCan 2000a; NRCan 2001).

In May 2000, all of 16 Canadian home building supply companies announced their commitment to phase out wood and wood products from forests managed unsustainably, including old growth from BC's North Coast (Sierra Club 2000). Certification, in which labels are applied to products from well-managed forests (see Box 48), is an emerging response to the growing demand for wood that is sustainably harvested, and increasingly, export markets require the certification of timber products from the Pacific Northwest. Today, certified wood accounts for only 1.0 percent of

global supply and companies cannot keep up with demand (McKenna 2000).

Stakeholders in the Pacific Northwest continue to come together to resolve contentious issues. In November 2000, for example, a number of key ENGOs and logging companies, the BC government, and First Nations reached a consensus agreement in the largest rainforest conservation measure in North American history. The Great Bear Rainforest Agreement protects 603,000 ha of coastal temperate rainforest and defers logging on another 800,000 ha for two years of studies. It is based on developing a locally administered ecosystem and land use planning approach between the BC government and First Nations. Some 4,500 people live in the area, most of them First Nations. The agreement is a landmark sign of cooperation among previously conflicting interests (Sierra Club 2001; Judd 2001; BC Ministry of Forests 2001b).

Over the past 30 years, the timber industry and the governments responsible for North America's old-growth forests have gradually been influenced by the combined power of scientific knowledge, the action of voluntary groups, public awareness, and market pressures (Dietrich 1992; Apsey, Laishley, and others 2000). At the same time, society continues to demand forest products and the associated economic benefits from harvesting timber, such as direct and indirect jobs, government revenues, and the host of forest products in everyday use (FPB 2002). Adopting a new paradigm in managing North America's old-growth forests while continuing to compete to supply a growing worldwide demand for wood has been a challenge for both governments and the forest industry (NRCan 2000a). Using North America's forests sustainably will still require the maintaining and improving of government intervention, industry compliance, market incentives, scientific knowledge, watchfulness of civil society groups, public education, and resource use efficiency.

References

Apsey, Mike, Don Laishley, Vidar Nordin, and Gilbert Paillé (2000). *The Perpetual Forest: Using Lessons from the Past to Sustain Canada's Forests in the Future*, Natural Resources Canada

Bartuska, Ann (2000). *Statement of Ann Bartuska Director of Forest Management Forest Service, United States Department of Agriculture, before the Subcommittee on Forests and Forest Health, Committee on Resources United States House of Representatives, July 25, 2000 Concerning The Future of National Forest Timber Sales.* Committee on Resources, Subcommittee on Forests & Forest Health http://resourcescommittee.house.gov/106cong/forests/00jul25/bartuska.htm. Accessed 4 March 2002

BC Ministry of Forests (1998). *Coastal Temperate Rainforests of British Columbia.* BC Ministry of Forests http://www.for.gov.bc.ca/PAB/PUBLCTNS/International/three/three.htm

BC Ministry of Forests (2001a). Old Growth Forests. *Growing Together: Forest Management in British Columbia.* Government of British Columbia http://www.growingtogether.ca/facts/old_growth.htm. Accessed 4 March 2002

BC Ministry of Forests (2001b). Central Coast (Great Bear Rainforest). *Growing Together: Forest Management in British Columbia.* Government of British Columbia http://www.growingtogether.ca/centralcoast/index.htm. Accessed 20 February 2002

BFW (1997). Boreal Forest Ecology Basics. *The Boreal Ecosystem.* Boreal Forest Watch http://www.bfw.sr.unh.edu/html/files/bor-eco.html. Accessed 19 February 2002

Bright, Chris (1999). The Nemesis Effect. *World Watch* 12 (3):12-23

Bruce, James P., Ian Burton, and I.D. Mark Egener (1999). *Disaster Mitigation and Preparedness in a Changing Climate: A Synthesis Paper Prepared for Emergency Preparedness Canada, Environment Canada, and the Insurance Bureau of Canada.* Ottawa, Minister of Public Works and Government Services http://www.epc-pcc.gc.ca/research/down/DisMit_e.pdf. Accessed 13 February 2002

Bryant, Dirk, Daniel Nielsen, and Laura Tangley (1997). *The Last Frontier Forests: Ecosystems & Economies on the Edge: What is the Status of the World's Remaining Large, Natural Forest Ecosystems?* Washington, DC, World Resources Institute, Forest Frontiers Initiative

CAS (2002). *The North American Maple Project.* Penn State, College of Agricultural Sciences http://research.cas.psu.edu/research_programs/north_american_maple.htm. Accessed 29 February 2002

CBD (2000). The Clayoquot Sound Challenge: Protecting Ancient Temperate Rainforests While Providing Sustainable Resources For The Nuu Chah Nulth Indian Nation. *Real Stories.* Conservation Based Development http://www.explorecbd.org/stories/clayoquot/default.html. Accessed 4 March 2002

CNW (2000). *British Columbia Community Celebrates Designation of Clayoquot Sound as an International Biosphere Reserve*. Canadian News Wire http://www.newswire.ca/releases/May2000/05/c2312.html. Accessed 4 March 2002

Dietrich, William (1992). *The Final Forest: The Battle for the Last Great Trees of the Pacific Northwest.* New York, Simon & Schuster

Driscoll, Charles T., Gregory B. Lawrence, Arthur J. Bulger, Thomas J. Butler, Christopher S. Cronan, Christopher Eagar, Kathleen F. Lambert, Gene E. Likens, John L. Stoddard, and Kathleen C. Weathers (2001). Acidic Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies. *BioScience* 51 (3):180-98

EC (2000). *Canada–United States Air Quality Agreement 2000: Progress Report.* Environment Canada http://www.ec.gc.ca/special/aqa_2000_e.pdf. Accessed 14 February 2002

ENS (1999). Natives, Enviros, MacMillan Bloedel Sign Clayoquot Truce. *Environment News Service*, E-Wire Press Release http://ens.lycos.com/ens/jun99/1999L-06-17-03.html. Accessed 4 March 2002

FAO (2001a). *Global Forest Resources Assessment 2000.* FAO Forestry Paper 140. Rome, Food and Agricultural Organization http://www.ers.usda.gov/emphases/harmony/issues/organic/table4graph.htm. Accessed 31 May 2002

FAO (2001b). State of the World's Forests 2001. Rome, Food and Agricultural Organization of the United Nations http://www.fao.org/forestry/fo/sofo/SOFO2001/sofo2001-e.stm. Accessed 29 May 2002

FPB (2002). *Alternatives to Conventional Clearcutting*. Forest Practices Branch, Ministry of Forests, Government of British Columbia http://www.for.gov.bc.ca/hfp/pubs/standman/atcc/atcc.htm. Accessed 27 February 2002

FSC–Can (1996). *Forest Stewardship Council of Canada* http://www.fsccanada.org/. Accessed 18 February 2002

FSC–US (2001). *FSC–US National Indicators for Forest Stewardship*. Forest Stewardship Council United States http://www.fscstandards.org/. Accessed 18 February 2002

Gawthrop (1999). *Vanishing Halo: Saving the Boreal Forest*. Vancouver/Toronto, Greystone Books

GFW (2000). *Canada's Forests at a Crossroads: An Assessment in the Year 2000, Global Forest Watch Canada*. Washington, DC, World Resources Institute

Ghazali, Baharuddin Haji (1994). *Timber Certification: an Overview*. FAO Corporate Document Repository http://www.fao.org/docrep/v7850e/V7850e04.htm. Accessed 18 February 2002

H. John Heinz III Center (1999). *Designing a Report on the State of the Nation's Ecosystem: Selected Measurements for Croplands, Forests, and Coasts and Oceans*. The H. John Heinz III Center for Science, Economics and the Environment http://www.heinzcenter.org/publications/Coasts.pdf. Accessed 12 February 2002

Hammond, Herb (1993). Clearcutting: Ecological and Economic Flaws. In *Clearcut: The Tragedy of Industrial Forestry*. San Francisco, Sierra Club Books and Earth Island Press

Harmon, Frances (1993). Acres of Late-Successional and Old-Growth Forest: The Wealth of Humboldt and the Klamath-Siskiyou Region. In *Forest Ecosystem Management: An Ecological, Economic, & Social Assessment, A Report of the Forest Ecosystem Management Assessment Team*, http://www.humboldt.edu/~envecon/Indicators/acresofoldgrowth.htm. Accessed 15 March 2002

Hopkin, A.A., D. Lachance, B. Pendrel, and J.P Hall (1996). Condition of Sugar Maple in Canada: Results of the North American Maple Project. Paper read at EMAN Second National Meeting. Abstracts of Papers and Posters, Ecological Monitoring and Assessment Network, Environment Canada http://www.eman-rese.ca/eman/reports/meetings/national96/hopkina.html. Accessed 28 February 2002

Jones, Laura , Laura Griggs, and Liv Fredricksen (2000). *The Fraser Institute Environmental Indicators*. The Fraser Institute http://oldfraser.lexi.net/publications/critical_issues/2000/env_indic/. Accessed 4 March 2002

Judd, Neville (2001). *Peace Breaks Out in War Over Canadian Rainforest*. Environmental News Service (ENS) http://ens.lycos.com/ens/apr2001/2001L-04-04-10.html. Accessed 20 February 2002

Lund, H. Gyde (2000). *Definitions of Old Growth, Pristine, Climax, Ancient Forests, and Similar Terms. (Definitions Of Forest State, Stage, and Origin)*. H. Gyde Lund, Forest Information Services http://home.att.net/~gklund/pristine.html. Accessed 4 March 2002

MacKinnon, A., and M. Eng. (1995). Old Forests Inventory for Coastal British Columbia. *Cordillera* 2 (1):20-33

Marchak, M. Patricia, Scott L. Aycock, and Doborah M. Herbert (1999). *Falldown: Forest Policy in British Columbia*. Vancouver, David Suzuki Foundation and Ecotrust Canada

Maser, Chris (1993). Sustainable Forestry. In *Clearcut: The Tragedy of Industrial Forestry*. San Francisco, Sierra Club Books and Earth Island Press

Mathews, Emily, and Allen Hammond (1999). *Critical Consumption Trends and Implications: Degrading Earth's Ecosystems*. Washington DC, World Resources Institute

Mattoon, Ashley T. (1998). Paper Forests. *World Watch* 11 (2):20-28

May, Elizabeth (1998). *At the Cutting Edge: The Crisis in Canada's Forests*. Toronto, Key Porter Books

McKenna, Barrie (2000). US Environmentalists Swing Axe at Canadian Forest Industry. *The Globe and Mail*, 22 January

McLaughlin, D. (1996). A Decade of Forest Health Monitoring in Canada: Evidence of Air Pollution Effects. Paper read at the Second National Science Meeting, Ecological Monitoring and Assessment Network (EMAN), 19 January, at Halifax, Nova Scotia

MPCI (1998). *The Montreal Process/ Le Processus de Montreal* http://www.mpci.org/. Accessed 19 February 2002

MSRM (2002). *Special Projects – Clayoquot Sound*. Government of British Columbia, Ministry of Sustainable Resource Management http://www.luco.gov.bc.ca/specialprojects/clayquot/index.htm. Accessed 4 March 2002

NAFC (2000). *North American Forest Commission: Working Groups*. North American Forest Commission http://www.fs.fed.us/global/nafc/welcome.html. Accessed 29 February 2002

NFDP (1998). *REGEN: A Program for Reporting Regeneration Results*. National Forestry Database Program http://nfdp.ccfm.org/regen/english/regen-frame.htm. Accessed 4 March 2002

NRCan (1995). *ARNEWS and North American Maple Project (NAMP)*. Natural Resources Canada http://nrcan.gc.ca/cfs/proj/sci-tech/arnews/abstract_e.html. Accessed 29 February 2002

NRCan (1999). *Forest Health: Context for the Canadian Forest Service's Science Program*. Science Branch, Canadian Forest Service, Natural Resources Canada http://www.nrcan.gc.ca/cfs/proj/sci-tech/context_health/mainpage_e.html. Accessed 4 March 2002

NRCan (2000a). *The State of Canada's Forests: 1999–2000 Forests in the New Millennium*. Natural Resources Canada http://www.nrcan.gc.ca/cfs/proj/ppiab/sof/sof00/toc.shtml. Accessed 4 March 2002

NRCan (2000b). *Defining Sustainable Forest Management: A Canadian Approach to Criteria and Indicators*. Natural Resources Canada, Canadian Forest Service, Canadian Council of Forest Ministers http://www.nrcan.gc.ca/cfs/proj/ppiab/ci/framain_e.html. Accessed 19 February 2002

NRCan (2000c). *The State of Canada's Forests: 1998–1999 Innovation, Protected Areas: Safeguarding Canada's Biodiversity*. Natural Resources Canada http://www.nrcan.gc.ca/cfs/proj/ppiab/sof/sof99/spart1.shtml. Accessed 4 March 2002

NRCan (2000d). *Long Beach Model Forest Network*. Natural Resources Canada, Canadian Forest Service http://www.lbmf.bc.ca/. Accessed 19 February 2002

NRCan (2001). *The State of Canada's Forests: 2000–2001*. Natural Resources Canada http://www.nrcan-rncan.gc.ca/cfs-scf/national/what-quoi/sof/latest_e.html. Accessed 29 February 2002

Pace, Felice (1993). Cultural Clearcuts: The Sociology of Timber Communities in the Pacific Northwest. In *Clearcut: The Tragedy of Industrial Forestry*. San Francisco, Sierra Club Books and Earth Island Press

PBS (1999). *Newton's Apple Teacher's Guides: Spotted Owl/Old-Growth Forests*. Twin Cities Public Television, Public Broadcasting Service http://www.pbs.org/ktca/newtons/11/oldgrwth.html#VOCAB. Accessed 4 March 2002

PFC (2000). *Ecology and Ecosystems: Montane Alternative Silviculture Systems (MASS)*. Pacific Forestry Centre, Natural Resources Canada http://www.pfc.forestry.ca/ecology/ferns/mass/index_e.html. Accessed 27 February 2002

Porter, William F., and Jennifer A. Hill (1998). Regional Trends of Biological Resources: Northeast. In *Status and Trends of the Nation's Biological Resources*, edited by M. J. Mac, P. A. Opler, C. E. Puckett Haecker and P. D. Doran. Washington DC, US Department of the Interior and US Geological Survey

PR Newswire (1998). *MacMillan Bloedel to Phase Out Clearcutting*. Forests.org http://forests.org/archive/canada/moreonbc.htm. Accessed 4 March 2002

Salonius, P. (2001). Management for Acadian Mixedwoods in New Brunswick. *Forest Health and Biodiversity News* 5 (2):3, 5-6

Sierra Club (2000). *Forest Policy & Economics: Sustainable Forests, Sustainable Communities*. Sierra Club British Columbia http://www.sierraclub.ca/bc/campaigns/forest_policy/#Cutting for the Economy's Sake. Accessed 4 March 2002

Sierra Club (2001). *Environmental Groups Express Cautious Optimism About Government Plans for British Columbia's Coast*. The Sierra Club http://bc.sierraclub.ca/News/Media_Releases/Cautious.html. Accessed 20 February 2002

Stuart, John D. (1998). Effects of Fire Suppression on Ecosystems and Diversity. In *Status and Trends of the Nation's Biological Resources*, edited by M. J. Mac, P. A. Opler, C. E. Puckett Haecker and P. D. Doran. Washington DC, US Department of the Interior and US Geological Survey

Taylor, Charles (1997). *Summary Report on Forest Health of the United States by the Forest Health Science Panel*. The US House of Representatives http://www.house.gov/resources/105cong/fullcomm/apr09.97/taylor.rpt/tay-sum.pdf. Accessed 20 February 2002

TRN (1998). The Boreal Forest: A Brief Status Report. Background Paper for the 4th Taiga Rescue Network Conference, "Boreal Forests of the W orld IV: Integrating Cultural Values into Local and Global Forest Protection", October, at Tartu, Estonia, October

Turner, Monica G., Stephen R. Carpenter, Eric J. Gustafson, Robert J. Naiman, and Scott M. Pearson (1998). Land Use. In *Status and Trends of the Nation's Biological Resources*, edited by M.J. Mac, P.A. Opler, C.E. Puckett Haecker and P.D. Doran. Washington DC, US Department of the Interior and US Geological Survey

UN (1997). *Institutional Aspects of Sustainable Development*. United Nations Sustainable Development: UN System-Wide Web Site on National Implementation of the Rio Commitments http://www.un.org/esa/agenda21/natlinfo/index.html. Accessed 4 March 2002

UN-ECE, and FAO (2000). *Forest Resources of Europe, CIS, North America, Australia, Japan and New Zealand (industrialized temperate/boreal counties)*. Vol. UN-ECE/FAO Contribution to the Global Forest Resources Assessment 2000; Geneva Timber and Forest Study Papers, No. 17. New York and Geneva, United Nations

UNDP, UNEP, World Bank, and WRI (2000). *World Resources 2000-2001: People and Ecosystems, the Fraying Web of Life*. Washington DC, World Resources Institute

University of Waterloo (1998). *World Wide Web Resources on Parks and Protected Areas*. University of Waterloo, Faculty of Applied Health Sciences, Department of Recreation and Leisure Studies http://www.ahs.uwaterloo.ca/rec/parksoption/parkslinks99.htm. Accessed 4 March 2002

Urquizo, Natty, J. Bastedo, Tom Brydges, and Harvey Shear (2000). Ecological Assessment of the Boreal Shield Ecozone. A State of the Environment Report. Ottawa, National Indicators and Assessment Office, Environment Canada http://www.ec.gc.ca/soer-ree/English/National/craengfin.pdf. Accessed 28 May2002

USDA (1997). *America's Forests: 1997 Health Update*. US Department of Agriculture, Forest Service http://www.fs.fed.us/foresthealth/fh_update/update97/index.htm. Accessed 4 March 2002

USDA (2002). *Sustainable Resource Management*. US Department of Agriculture, Forest Service http://www.fs.fed.us/sustained/msie4.html. Accessed 19 February 2002

WRM (1998). *The Underlying Causes of Deforestation and Forest Degradation*. World Rainforest Movement http://www.wrm.org.uy/. Accessed 4 March 2002